Science of the Total Environment 571 (2016) 834–854

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Short-term influence of coal mine reclamation using coal combustion residues on groundwater quality

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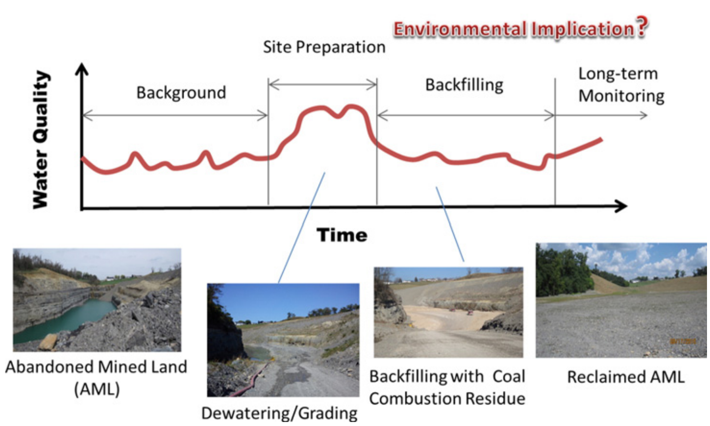
HIGHLIGHTS

- Coal combustion by-products (CCBs) were used to reclaim two abandoned mined sites.
- Environmental impacts of the reclamation projects were examined.
- The water quality at both demonstration sites had changed since the reclamation began.
- Altered hydrogeological conditions and backfilled CCBs caused water quality change.
- No indication suggests adverse impacts to the surrounding environments.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 8 February 2016
Received in revised form 8 July 2016
Accepted 8 July 2016
Available online 21 July 2016

Editor: D. Barcelo

Keywords:
Coal mine reclamation
Coal combustion residues
Flue gas desulfurization
Groundwater
Hydrochemical property
Multivariate statistical analysis

ABSTRACT

Two full-scale coal mine reclamation projects using coal combustion residues (CCRs) were recently carried out at highwall pit complexes near the Conesville and Cardinal coal-fired power plants owned by American Electric Power. The environment impacts of the reclamation projects were examined by regularly monitoring the leaching characteristics of the backfilling CCRs and the water quality of the uppermost aquifers underlying the sites. With over five years of field monitoring, it shows that the water quality at both demonstration sites had changed since the reclamation began. By analyzing the change of the hydrogeochemical properties, it was concluded that the water quality impact observed at the Conesville Five Points site was unlikely due to the seepage of FGD material leachates. Reclamation activities, such as logging, grading, and dewatering changed the hydrogeological conditions and resulted in the observed water quality changes. The same hydrogeological effect on water quality was also found at the Cardinal Star Ridge site during the early stage of the reclamation (approximately the first 22 months). Subsequent measurements showed the water quality to be strongly influenced by the water in the reclaimed highwall pit. Despite the changes to the water quality, the impacts are insignificant and temporary. None of the constitutes showed concentration levels higher than the regulatory leaching limits set by the Ohio Department of Natural Resources' Division of Mineral Resources Management for utilizing CCRs in mined land reclamation. Compared to the local aquifers, the concentrations of eleven selected constituents remained at comparable levels throughout the study period. There are four constituents (i.e., As, Be, Sb,

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http://dx.doi.org/10.1016/j.scitotenv.2016.07.061

and Tl) that exceeded their respective MCLs after the reclamation began. These detections were found shortly (i.e., within 2 years) after the reclamation began and decreased to the levels either lower than the respective detection limits or similar to the background levels.

1. Introduction

Abandoned mine lands (AMLs) pose risks to the public and the environment by potentially disrupting the flow of nearby surface water streams, discharging highly acidic and metal-enriched acid mine drainage (AMD), creating dangerous highwalls, and degrading habitat that threatens animal species. The Bureau of Land Management estimated that there are as many as 500,000 AML sites in the United States (2015). Currently in Ohio, there are over 200,000 acres of unreclaimed surface mines and over 600,000 acres of abandoned underground mines (Wolfe et al., 2009).

The reclamation of AMLs is needed in order to improve the quality of the environment and eliminate the hazards within AML impacted regions (Stehouwer et al., 1996). Reclaiming AMLs using coal combustion residues (CCRs), including fly ash, sulfate-rich FGD gypsum, and stabilized, sulfite-rich FGD material (a mixture of lime, fly ash and FGD filter cake), has been suggested as an effective and economically viable approach (Stehouwer et al., 1996; Butalia, 2009). It has been shown that

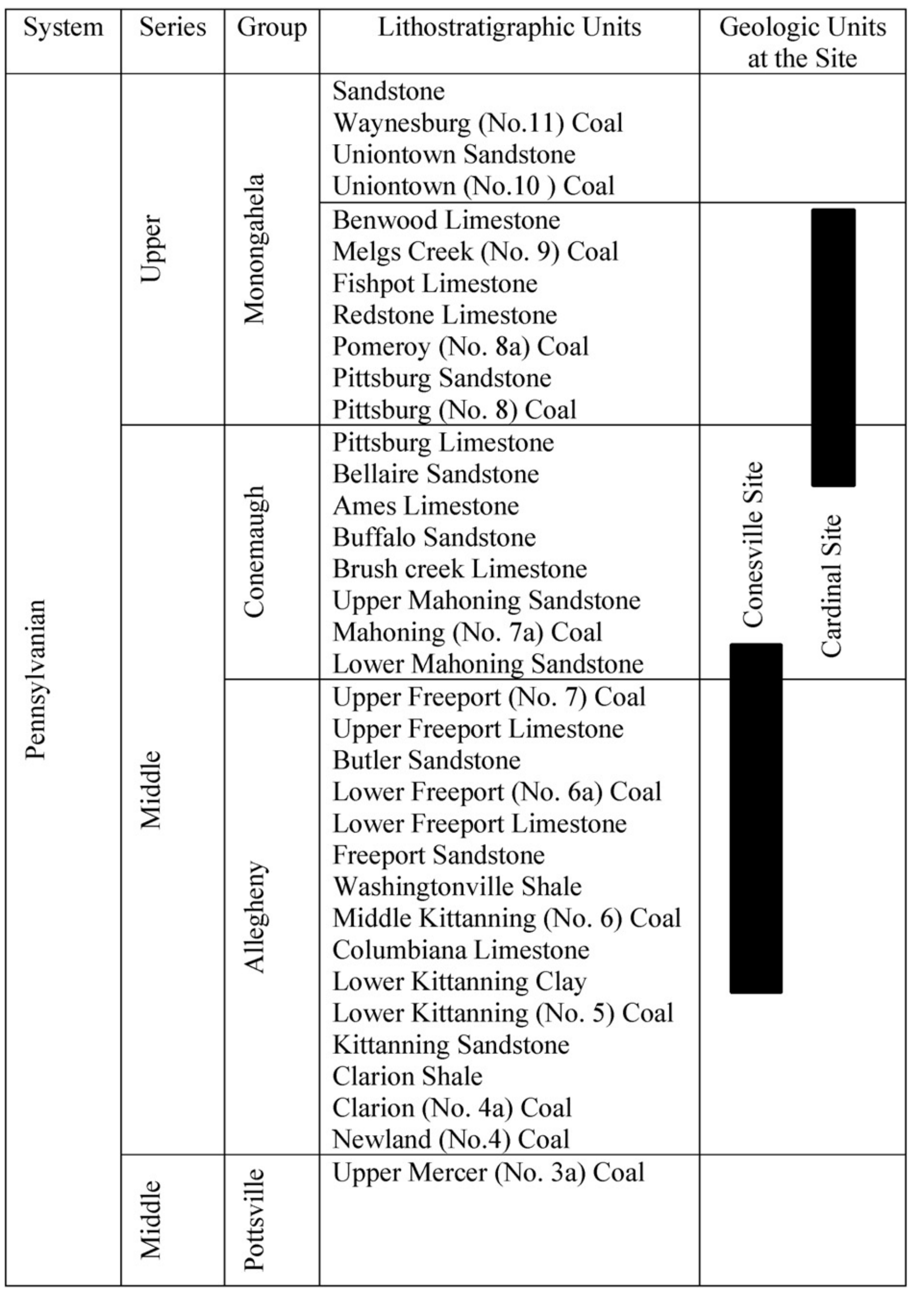

Fig. 1. Stratigraphic chart illustrating geologic units in eastern Ohio (ODNR-DGS, 2014).